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भाग 5 काल प्रभावन ओवन

अनुभाग 3 बहु-चैम्बर ओवन

Indian Standard

ELECTRICAL INSULATING MATERIALS — THERMAL ENDURANCE PROPERTIES

PART 5 AGEING OVENS

Section 3 Multi-chamber Ovens

ICS 17.220.99; 19.020; 29.035.01

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NEW DELHI 110002

December 2012 **Price Group 5**

Solid Electrical Insulating Materials and Insulating Systems Sectional Committee, ETD 02

NATIONAL FOREWORD

This Indian Standard (Part 5/Sec 3) which is identical with IEC 60216-4-3 : 2000 ‘Electrical insulating materials — Thermal endurance properties — Part 4-3: Ageing ovens — Multi-chamber ovens’ issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Solid Electrical Insulating Materials and Insulating Systems Sectional Committee and approval of the Electrotechnical Division Council.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminology and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’.

b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60216-1 : 1990 Guide for the determination of thermal endurance properties of electrical insulating materials — Part 1: General guidelines for ageing procedures and evaluation of test results	IS 8504 (Part 1) : 2012 Electrical insulating materials — Thermal endurance properties : Part 1 Ageing procedures and evaluation of test results (*second revision*)	Idential to IEC 60216-1 : 2001
IEC 60216-3-1 : 1990 Guide for the determination of thermal endurance properties of electrical insulating materials — Part 3: Instructions for calculating thermal endurance characteristics — Section 1: Calculations using mean values of normally distributed complete data	IS 8504 (Part 4) : 2012 Electrical insulating materials — Thermal endurance properties: Part 4 Instructions for calculating thermal endurance characteristics (*first revision*)	Idential to IEC 60216-3 : 2006
IEC 60216-3-2 : 1993 Guide for the determination of thermal endurance properties of electrical insulating materials — Part 3: Instructions for calculating thermal endurance characteristics — Section 2: Calculations for incomplete data: proof test results up to and including the median time to end-point (equal test groups)		
IEC 60216-4-1 : 1990 Guide for the determination of thermal endurance properties of electrical insulating materials — Part 4: Ageing ovens — Section 1: Single-chamber ovens	IS 8504 (Part 5/Sec 1) : 2012 Electrical insulating materials — Thermal endurance properties: Part 5 Ageing ovens, Section 1 Single-chamber ovens	Idential to IEC 60216-4-1 : 2006

(*Continued on third cover*)

IS 8504 (Part 5/Sec 3) : 2012
IEC 60216-4-3 : 2000

Indian Standard

ELECTRICAL INSULATING MATERIALS — THERMAL ENDURANCE PROPERTIES

PART 5 AGEING OVENS

Section 3 Multi-chamber Ovens

1 Scope

This part of IEC 60216 covers the minimum requirements for ventilated and heated multi-chamber ovens used for thermal endurance evaluation of electrical insulation and of any other appropriate thermal conditioning application where the use of single-chamber ovens is inappropriate.

It covers ovens designed to operate over all or part of the temperature range from 20 K above ambient to 500 °C.

It gives acceptance tests and in-service monitoring tests for both unloaded and loaded multi-chamber ovens and conditions of use.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60216. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60216 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60216-1:1990, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 1: General guidelines for ageing procedures and evaluation of test results (under revision)*

IEC 60216-3-1:1990, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 3: Instructions for calculating thermal endurance characteristics – Section 1: Calculations using mean values of normally distributed complete data*

IEC 60216-3-2:1993, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 3: Instructions for calculating thermal endurance characteristics – Section 2: Calculations for incomplete data: proof test results up to and including the median time to end-point (equal test groups)*

IEC 60216-4-1:1990, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 4: Ageing ovens – Section 1: Single-chamber ovens*

3 Definitions

For the purposes of this part of IEC 60216, the following definitions apply:

3.1
rate of ventilation

number of air changes per hour in the exposure chamber at room temperature. Any calculation of the velocity of the air is based on the cross-sectional area of the chamber measured in a plane that intersects the working volume and is made assuming plug flow

3.2
exposure volume

that central part of each chamber that meets the requirements for temperature variation

3.3
exposure temperature (see also global exposure temperature)

temperature selected for ageing test specimens to obtain data for the determination of effects of temperature on standardized test specimens

3.4
temperature fluctuation

maximum change in temperature at one point in the exposure volume over a period of 3 h

3.5
temperature difference

maximum difference of temperature between any two points in the exposure volume at any one time

3.6
temperature variation

difference between the highest temperature and the lowest temperature measured over a period of 3 h

3.7
global average temperature

an average temperature, calculated from the results of determinations made over a period of approximately 3 h using nine sensors spaced throughout the exposure volume of a chamber

NOTE The global average temperature is considered to be the initial effective global exposure temperature.

3.8
time constant

measure of the time taken for the temperature of a standard specimen to approach the cell temperature

3.9
temperature deviation

deviation of the exposure temperature from the nominal value due to the combination of temperature variation and the error of temperature measurement

4 Constructional requirements

4.1 General

The oven shall be soundly constructed using suitable materials. All electrical and other ancillary fittings shall be readily accessible for maintenance purposes.

The construction shall be fitted with equipment to switch off the oven and preferably sound an alarm when the temperature of the thermostatically controlled medium deviates from the allowable temperature range or if the supply of ventilating air fails.

4.2 Specimen chambers

The ovens shall consist of at least two open-topped, approximately cylindrical chambers with appropriate lids, mounted with their axis approximately vertical. Each lid shall form an effective seal with the chamber: the leakage of ventilating gas from the lid seal shall be no more than 5 % of the flow rate of ventilating gas to the specimen chamber.

NOTE 1 Some types of 'O' ring seals have been found to be satisfactory.

Unless otherwise specified, the individual chambers shall have a minimum diameter of 35 mm and a minimum length of 200 mm.

The materials of construction of the chambers, their lids and their internal parts shall not contain any copper, copper alloy or any material that may give off interfering volatiles over the temperature range of the oven, for example some silicone resins.

The design shall be such as to permit the chambers to be easily cleaned after each test.

The chambers shall be mounted in a thermostatically controlled heat transfer medium: for example in a metal block, a liquid or 'sand' bath, a saturated vapour bath or in an air circulating oven. Examples of typical designs are given in figures 1 and 2.

NOTE 2 The performance of air circulating ovens in this context is usually poorer than the alternative systems.

4.3 Ventilation

Each chamber shall be provided with a supply of continuously metered, filtered, pre-heated ventilating air, entering the chamber at one end and being exhausted through the other.

When specified in the purchase contract, provision shall be made for the use of ventilating gases other than air.

Ventilation rates in the range 5 to 20 changes per hour shall be available.

The incoming air shall be directed to the cylindrical wall of the chamber in such a manner as to produce turbulent flow throughout the cell and the general design shall be to minimize recirculation of the ventilating air within each chamber. In order to prevent cross-contamination of volatile components, ventilating air from one chamber shall not come into contact with specimens in any other chamber. It is recommended that the exhaust from the chambers be vented to outside atmosphere, but precautions shall be taken to ensure that volatiles produced by the ageing specimens do not damage health or the environment.

Consideration shall be given to ensure adequate purity of the incoming ventilating air to minimize influence on the results. In cases where the results of tests are influenced by impurities in the ventilating medium, e.g. water vapour, it shall be controlled and reported.

4.4 Specimen mounting arrangements

Provision shall be made for supporting/suspending and positioning specimens within each chamber. The specimens shall not touch each other nor touch the chamber walls. The specimen and supports shall not occupy more than 25 % of the cross-sectional area of the chamber in any one plane, nor more than 50 % of the longitudinal cross-sectional area in any one plane, nor more than 10 % of the effective working volume of the chamber.

4.5 Temperature control

The temperature in the exposure volume shall be controllable to the limits given in 5.1.1.

5 Test methods and performance requirements

5.1 Temperature variation

5.1.1 Requirement

The exposure volume shall constitute at least the central 70 % of the volume of the chamber with the maximum allowable temperature variation given in table 1.

Table 1 – Maximum allowable temperature variation

Temperature range °C	Temperature variation K	Maximum allowable drift in global average temperature over 5-day period K
…≤ 100	2	1
100 < ..≤ 225	4	2
225 < ..≤ 300	6	3
300 < ..≤ 400	8	4
400 < ..≤ 500	10	5

5.1.2 Test method

5.1.2.1 A series of 3 mm maximum diameter temperature sensors shall be placed in the exposure volume of the chamber under investigation, ensuring that

a) one sensor is located within 10 mm of the centre of the chamber;

b) one sensor is located at the top of the volume under consideration and another sensor is located at the bottom of the volume, diametrically opposite to the top sensor;

c) six additional sensors are located so as to be approximately equidistant from the centre line and from each other.

Conduction of heat from the temperature sensor shall be minimized by ensuring that there is a sufficient length of connecting wire inside the oven and that externally the wires are routed close to or through the thermostatically controlled medium.

NOTE If calibrated temperature sensors (platinum resistance thermometers or thermocouples) are not available, thermocouples made from the same spools of thermocouple wire may be used provided that, when placed adjacent to one another in the testing chamber at the maximum operating temperature, they give values of temperature that do not differ by more than 0,2 K.

5.1.2.2 Raise the oven to its maximum operating temperature and allow it to stabilize. Measure the temperature of the sensors to 0,1 K a number of times over a period of approximately 3 h to allow identification of any cyclic behaviour and permit determination of the maximum, minimum and average temperatures of each thermocouple over the measuring period.

NOTE 1 From these readings, the temperature fluctuation at one point and the temperature difference at any one time can be easily calculated.

NOTE 2 Use of a data logger is advisable for this operation.

5.1.2.3 Calculate the average of the nine mean temperatures to 0,1 K and record this value as the global average temperature of the chamber.

5.1.2.4 Calculate the difference between the highest maximum temperature and the lowest minimum temperature determined according to 5.1.2.2 and record this as the temperature variation. This shall not exceed the values given in table 1.

5.1.2.5 Maintain the oven at the same set temperature for five days, i.e. 120 h. Measure the temperature variation once a day according to 5.1.2.2 and 5.1.2.4. This shall not exceed the values given in table 1. The global average temperature of the chamber shall be determined according to 5.1.2.3 during each of the six measuring periods. The maximum variation over the five-day period shall not exceed the values given in table 1.

5.2 Time constant

5.2.1 Requirement

When specified in the purchase contract the time constant shall not exceed a specified value.

NOTE This parameter is only of importance when the oven is used for short term thermal conditioning (thermal shock testing).

5.2.2 Test procedure

Provide a standard specimen consisting of a solid brass cylinder 10 mm ± 0,1 mm in diameter and 55 mm ± 0,1 mm long to which one junction of a differential thermocouple has been soldered.

Raise the oven temperature to 200 °C or its maximum designed temperature, whichever is the lower, and allow it to stabilize. Allow the standard specimen to stabilize at ambient temperature for approximately 1 h.

Following the manufacturer's instructions, open the chamber and quickly hang the standard specimen with it’s axis vertically and close to the geometric centre of the oven by the use of a heat resistant cord not larger than 0,25 mm diameter. Ensure that the free end of the thermocouple is suspended as far away as possible from the standard specimen without touching the walls of the chamber and within the effective working volume. Leave the chamber open for a total time of 60 s ± 2 s and then replace the lid on the chamber. Record the temperature difference every 10 s until the maximum has been established. Continue recording every 30 s until the temperature difference has dropped below 10 % of the maximum, and plot the values recorded against time in seconds.

Divide the maximum temperature difference by ten and record as T_{10}. Record as the time constant the time in seconds, taken from the plot of temperature difference versus time, for the temperature difference to pass through a maximum and decrease to T_{10}. This time constant shall not exceed the specified value.

6 Report

The supplier of the oven shall provide at least the following information:

a) range of oven temperatures over which the requirements for temperature variation conform with this standard;
b) range of available ventilation rates;
c) range of supply voltage over which the oven conforms with the standard, and the maximum power consumption;
d) maximum ambient temperature at which the oven conforms with the standard;
e) number of test chambers;
f) dimensions of the exposure volume of each chamber;
g) results of tests given in clause 4;
h) external dimensions;
i) mass of the complete (empty) oven;
j) recommendations on methods of controlling the quality of the ventilating air, e.g. filtration, dehumidification and appropriate methods of measurement.

7 Conditions of use and instructions for in-service monitoring by the user

7.1 Conditions of use

a) During use the ambient temperature and the supply voltage shall be controlled within the range stipulated by the manufacturer for correct performance of the oven.

b) Unless otherwise specified, the quality of the ventilating air shall be sufficient so as to not significantly affect the results.

c) The specimens and supports shall not occupy more than 25 % of the cross-sectional area of the chamber in any one plane, nor more than 50 % of the longitudinal cross-sectional area in any one plane nor more than 10 % of the total volume.

d) Only specimens from one compound shall be mounted in any one chamber unless it has been shown that the inclusion of specimens from other additional compounds with different compositions does not significantly affect the result.

It is recommended that facilities for making a continuous record of the temperature at one point in each chamber be made available.

7.2 In-service monitoring

The following tests on a specimen-loaded oven shall be made immediately before each ageing test.

NOTE These tests are to confirm that the loaded oven meets the requirements of this standard at the beginning of the ageing test. In the tests, the global exposure temperature and the temperature variation are determined.

Following the procedure given in 5.1.2.1 to 5.1.2.4 inclusive

a) place a series of temperature sensors in the chamber under examination,

b) raise the oven temperature to the intended ageing figure,

c) determine the global average temperature, and

d) determine the temperature variation.

The temperature variation shall be within the limits given in table 1.

If this is the case, record the global average temperature as the ageing temperature and proceed with the ageing programme.

If this is not the case, determine whether the oven is faulty or if the cause is due to the system of specimen loading.

Remove the cause of the problem and repeat the series of measurements to confirm that the temperature variation is in accordance with the requirements. Record the new global average temperature as the ageing temperature.

Repeat the measurements after 24 h. The temperature variation at this time shall still be within the limits given in table 1.

7.3 Report

The testing laboratory shall provide at least the following information:

- the set temperature,
- the global exposure temperature,
- the temperature variation at the global exposure temperature,
- details of the quality of the ventilating gas,
- any ageing data in the format specified in IEC 60216.

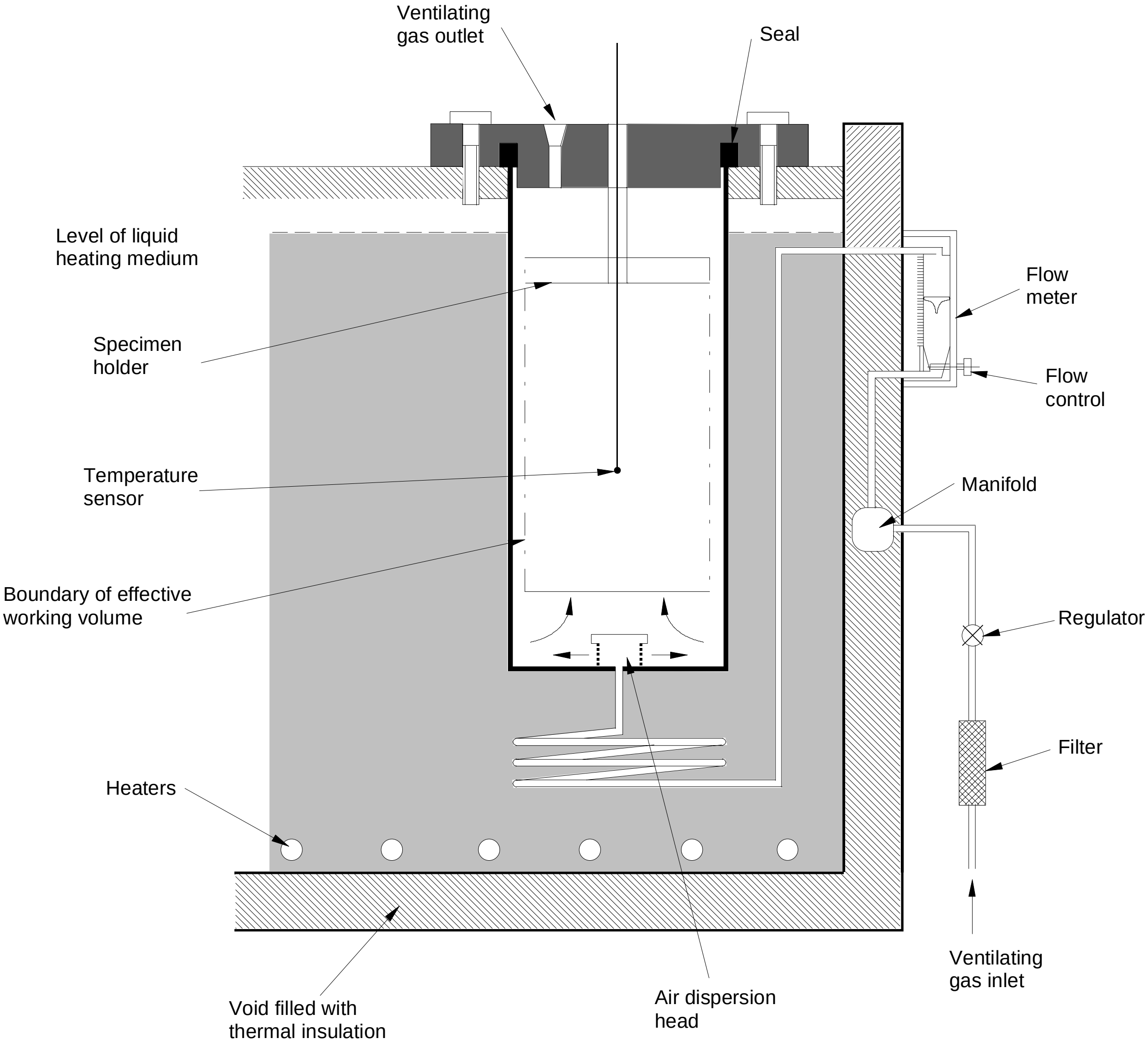

Figure 1 – Cell of a multi-chamber oven using a liquid heating medium

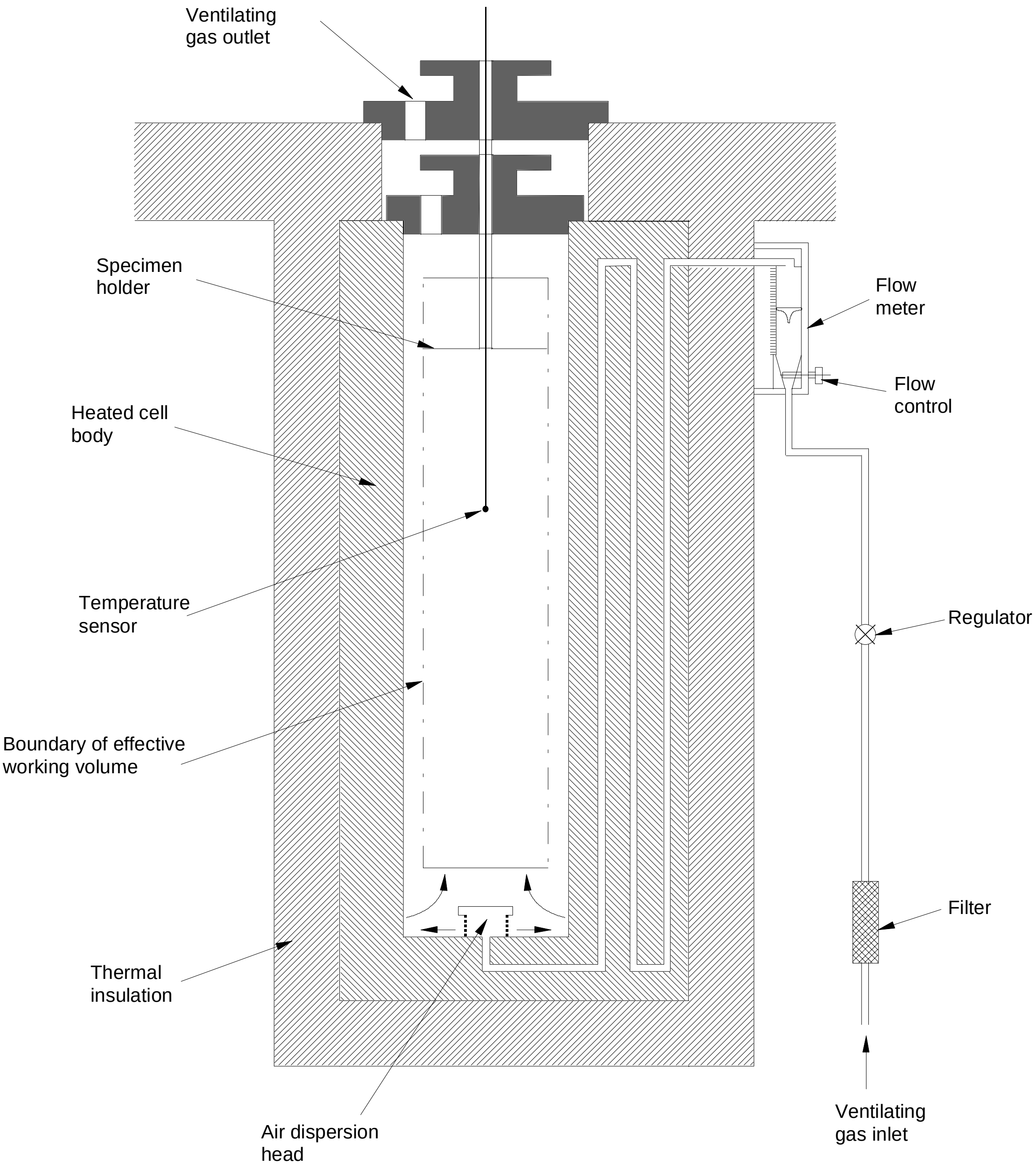

Figure 2 – Cell of a multi-chamber oven using a solid heating medium

(*Continued from second cover*)

Only the English language text has been retained while adopting it in this Indian Standard and as such the page numbers given here are not the same as in the IEC Publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: ETD 02 (6180).

Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

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Published by BIS, New Delhi